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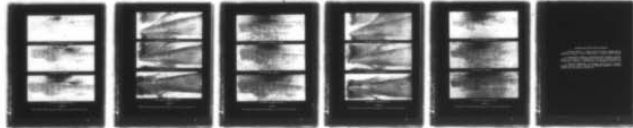
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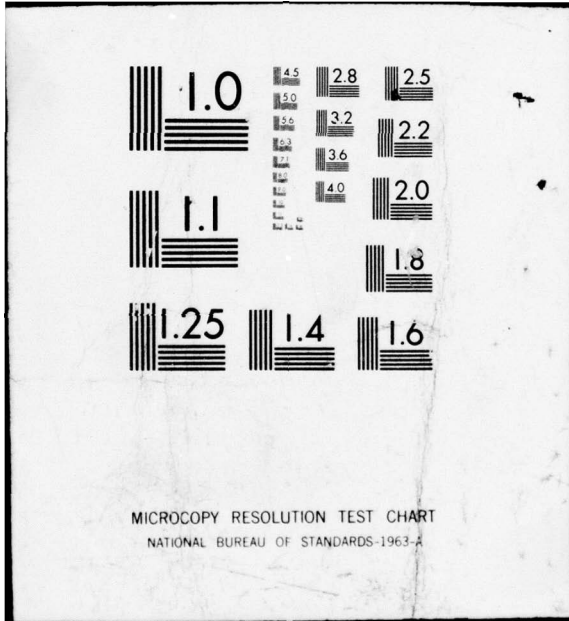
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INVESTIGATION OF THE FLOW PATTERNS OVER THE FORWARD HULL AND SONAR
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DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Md. 20084



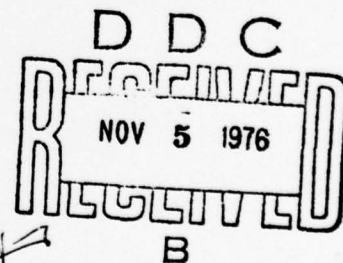
INVESTIGATION OF THE FLOW PATTERNS OVER THE
FORWARD HULL AND SONAR DOMES OF THE DESTROYER DDG-2
REPRESENTED BY MODEL 4645

by

R.J. Grady and N.E. Oliver

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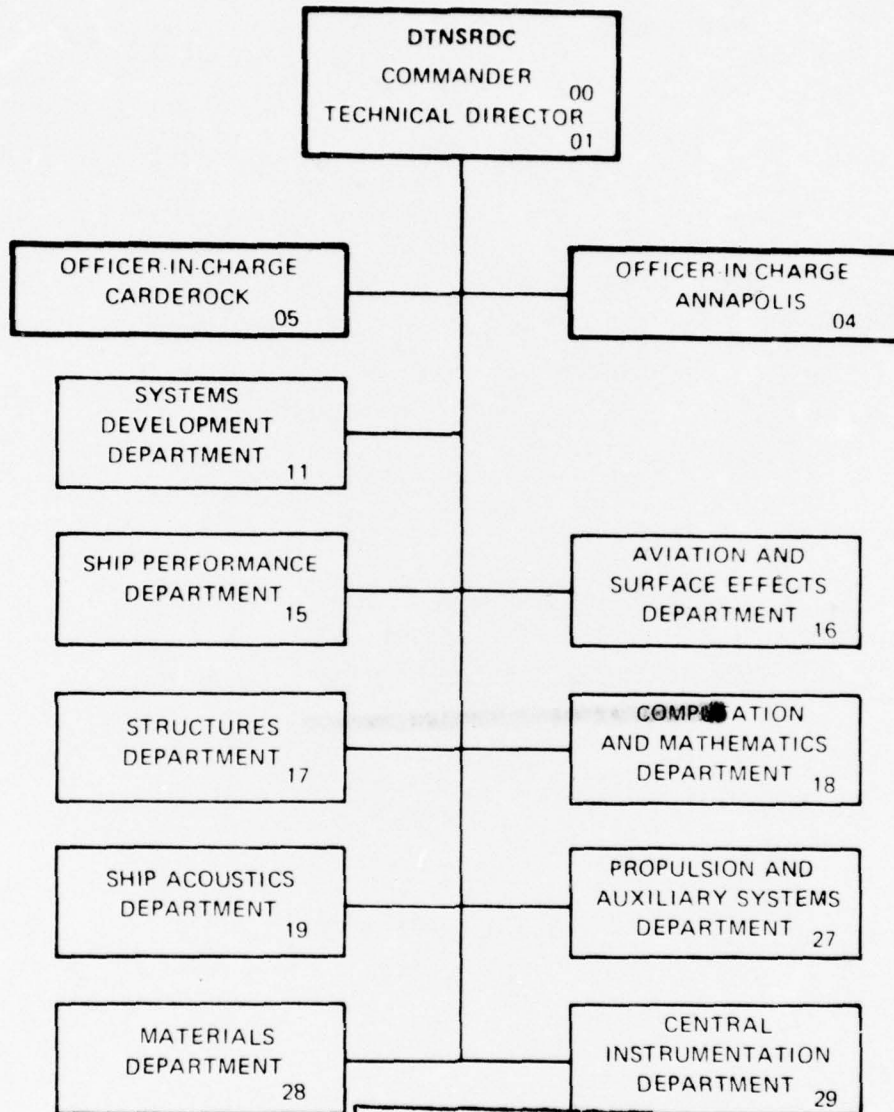
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| 1. REPORT NUMBER SPD-709-02 | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) INVESTIGATION OF THE FLOW PATTERNS OVER THE FORWARD HULL AND SONAR DOMES OF THE DESTROYER DDG-2 REPRESENTED BY MODEL 4645. | | 5. TYPE OF REPORT & PERIOD COVERED Final Rept. |
| 6. AUTHOR(s) R.J. Grady N.E. Oliver | | 7. PERFORMING ORG. REPORT NUMBER |
| 8. CONTRACT OR GRANT NUMBER(s) | | 9. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS N65197-76-PO60201 SPD-1524-589, and -596 |
| 10. CONTROLLING OFFICE NAME AND ADDRESS David W. Taylor Naval Ship R&D Center Bethesda, Maryland 20084 | 11. REPORT DATE SEPTEMBER 76 | 12. NUMBER OF PAGES 13 |
| 13. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) | 14. SECURITY CLASS. (of this report) UNCLASSIFIED | |
| 15. DECLASSIFICATION/DOWNGRADING SCHEDULE | | |
| 16. DISTRIBUTION STATEMENT (of this Report) APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED | | |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) | | |
| 18. SUPPLEMENTARY NOTES | | |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Flow Studies Destroyer USN DDG-2 Class ADAMS Class Sonar Domes Ship Model Tests | | |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Flow patterns about the forward hull and sonar domes were observed on a model of the DDG-2 through DDG-19 in the Circulating Water Channel. The speed was varied to simulate full-scale speeds from 18 knots (9.26 m/s) through 30 knots (15.43 m/s), with the yaw angle being set at zero degrees and ± three degrees. Side and bottom views of the flow patterns were recorded on photographs, which are included in the report. The flow patterns are satisfactory for all the conditions investigated. | | |

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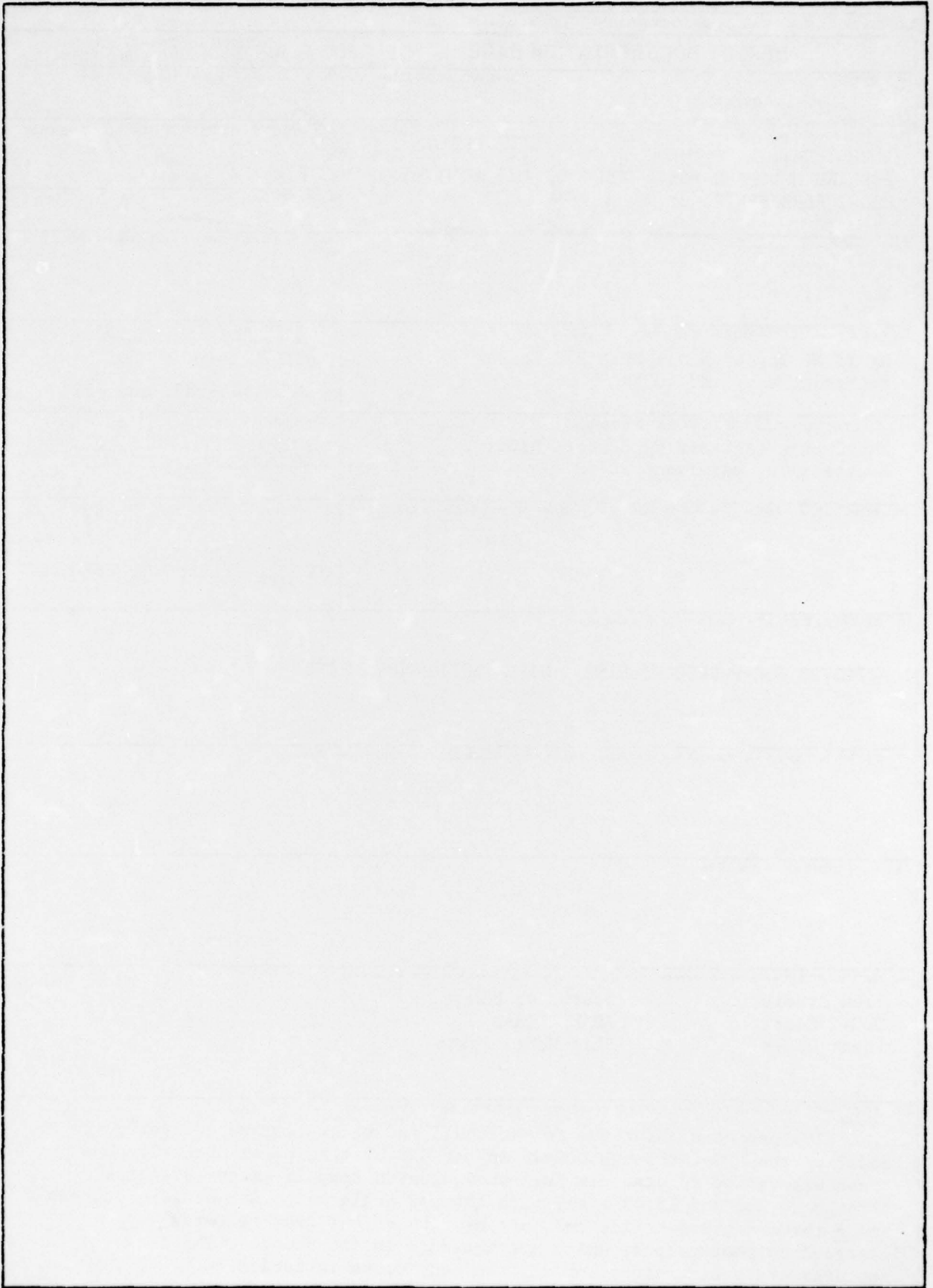


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INTRODUCTION

This study was conducted by the David W. Taylor Naval Ship Research and Development Center (DTNSRDC) to aid in the evaluation of the powering performance of the DDG-2 Class destroyer. The work was carried out as part of a larger effort in assistance to the Naval Ship Engineering Center (NAVSEC). This report presents the results of flow observation experiments at three yaw angles and various speeds. The results from the remainder of this effort have been published.

PROCEDURE

Model 4645 has a length at the design waterline of 19.513 ft (5.948 metres) and represents the 420 ft (128 metres) ship to a linear ratio of 21.524. This is the same model that was used in the powering performance experiments previously documented. The model specifically represents the hulls of DDG-2 through DDG-19. These hulls have two sonar domes mounted on the forward keel (see Figure 1). This configuration was selected for flow observations because of the possibility of adverse flow phenomena about the two domes.

The model was mounted in the circulating water channel (CWC) and ballasted with weights to a full-scale displacement of 4500 tons (4572 tonnes) at a trim of 8 inches (0.203 metres) by the stern. Although the model was not restrained in pitch or heave, it was restrained somewhat in roll (the mounting device allowed only small excursions in roll). Angles of yaw were obtained by the use of fixed holes in the mounting bracket arrangement. The restraining members were securely fixed to the channel I-beam structure.

Observations of flow patterns were made at yaw angles of three degrees to port, zero degrees, and three degrees to starboard. At each of these yaw angles, the flow was observed at speeds corresponding to 18, 22, 26, and 30 knots (9.26, 11.32, 13.37, and 15.43 m/s), full scale. Photographs were taken at each of these twelve conditions using cameras mounted at the side and bottom windows. Both cameras were at fixed locations throughout this investigation to facilitate subsequent comparisons between photographs of differing conditions. It should be noted that the side and bottom photographs at each condition were taken quasi-simultaneously using an oral countdown procedure. These photographs are presented in Figures 2 through 9, as follows:

| Velocity in Knots Ship (Model) | Yaw Angle (Degrees) | Side View | Bottom View |
|-----------------------------------|------------------------|-----------|-------------|
| 0.0 | 0 | Figure 1 | Figure 1 |
| 18 (3.87) | 0, +3, -3 | --- | Figure 2 |
| 18 (3.87) | 0, +3, -3 | Figure 3 | --- |
| 22 (4.74) | 0, +3, -3 | --- | Figure 4 |
| 22 (4.74) | 0, +3, -3 | Figure 5 | --- |
| 26 (5.60) | 0, +3, -3 | --- | Figure 6 |
| 26 (5.60) | 0, +3, -3 | Figure 7 | --- |
| 30 (6.47) | 0, +3, -3 | --- | Figure 9 |
| 30 (6.47) | 0, +3, -3 | Figure 9 | --- |

DISCUSSIONS AND CONCLUSIONS

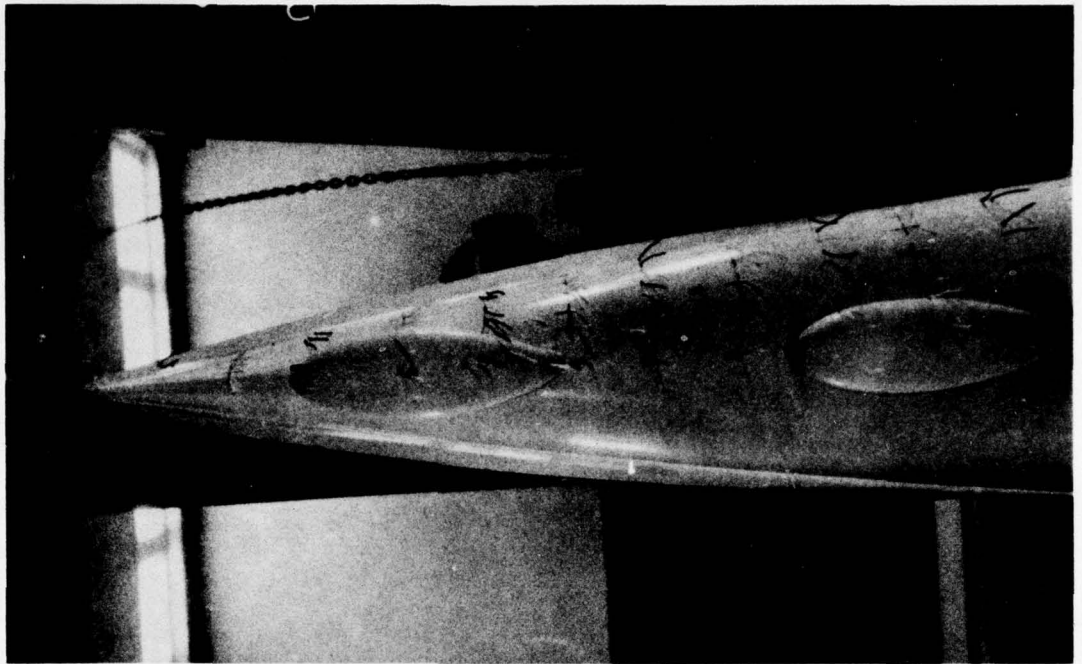
Since air is more readily ingested into the water at higher speeds, the photographs taken at these speeds are considerably marked with traces of air bubbles. Fortunately, the reduction in photographic quality is the only significant effect of these bubbles. Although these air bubbles do make it difficult to visualize the flow patterns recorded on the photographs, it was not very difficult to follow the flow with the naked eye during these experiments. Based on the photographs and the actual observations, the following conclusions have been drawn:

(1) The flow patterns about the bow and both sonar domes appeared to be entirely satisfactory.

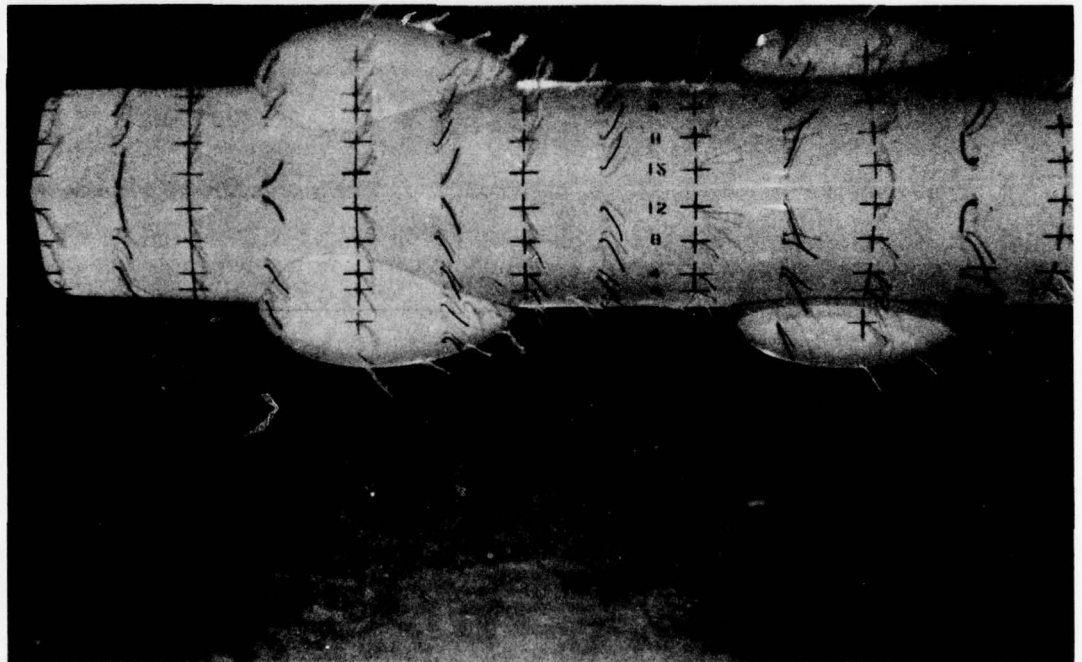
(2) The flow patterns between the domes were marginally satisfactory. Although there was some instability in the flow in this area, it was certainly no worse than that for ships having similar configurations.

(3) Although the bow wave is significantly affected by both speed and yaw angle, it does not appear that either of these has a significant effect on the flow patterns about the domes.

It should be mentioned that cognizant representatives of both NAVSEC Code 6136 and NAVSEA Code 9344 were present at the Circulating Water Channel for the flow observations documented herein. On the basis of their observations, these representatives concur with the conclusions presented herein.

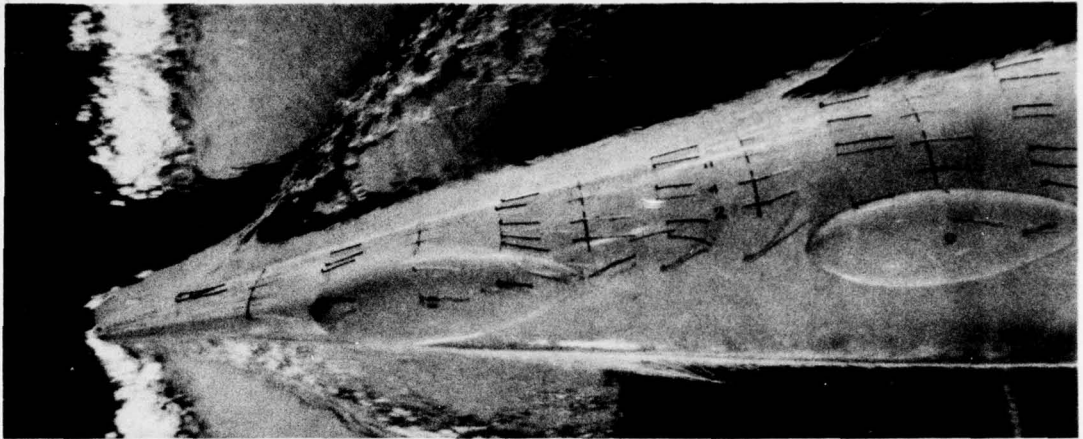


Yaw Angle Zero Degrees

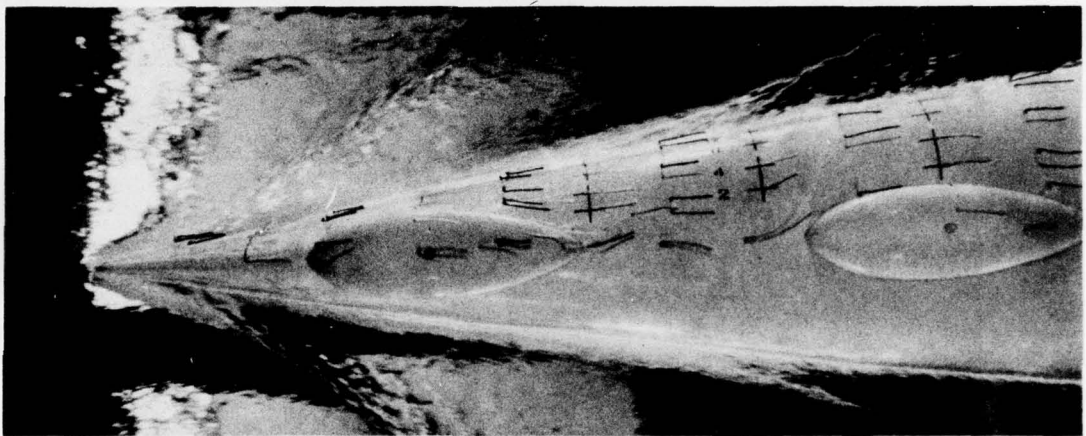


Yaw Angle Zero Degrees

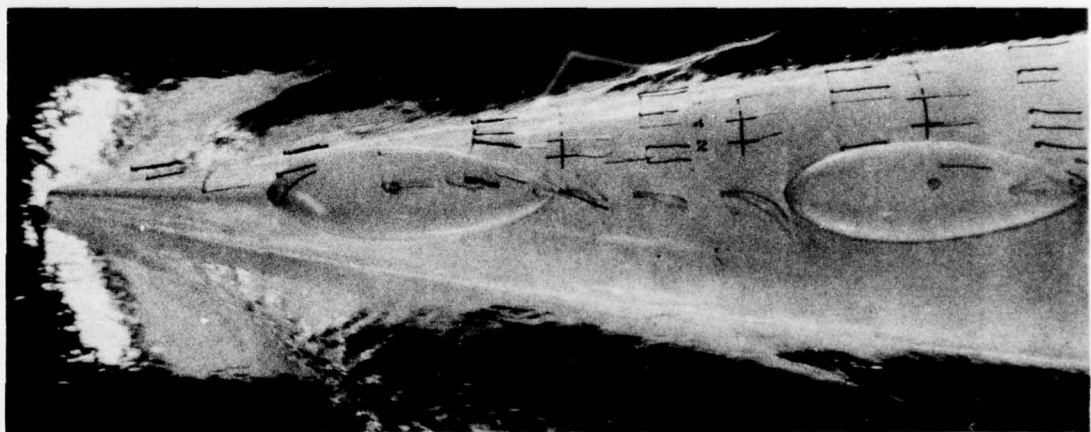
FIGURE 1
Side and Bottom Views at Zero Speed



Yaw Angle 3 Degrees to Stbd.



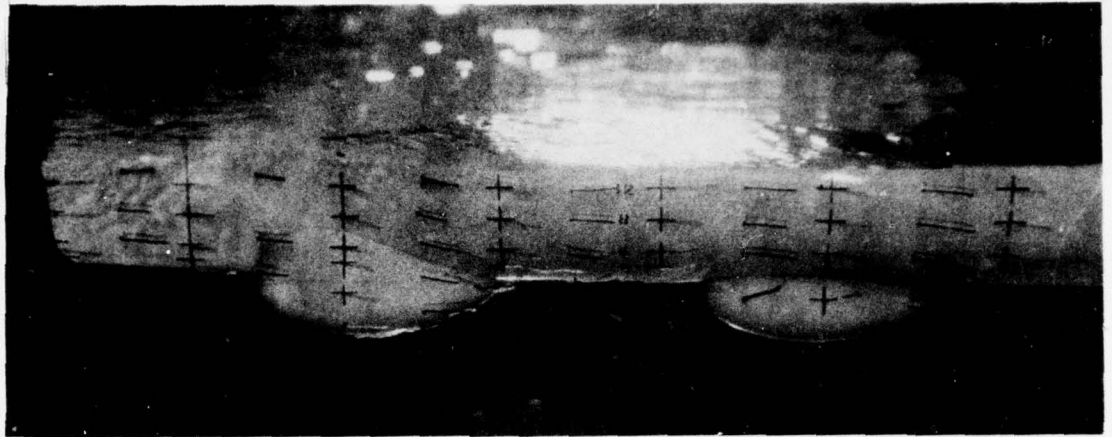
Yaw Angle Zero Degrees



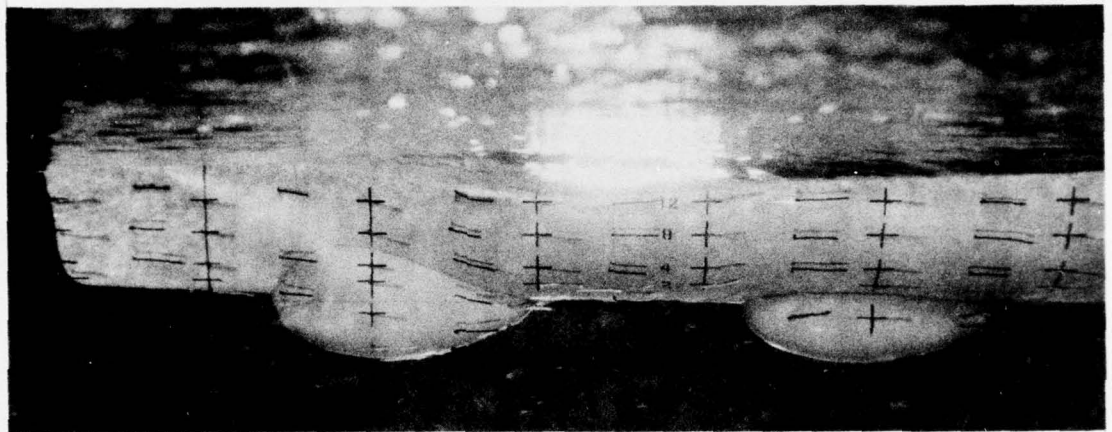
Yaw Angle 3 Degrees to Port

FIGURE 2

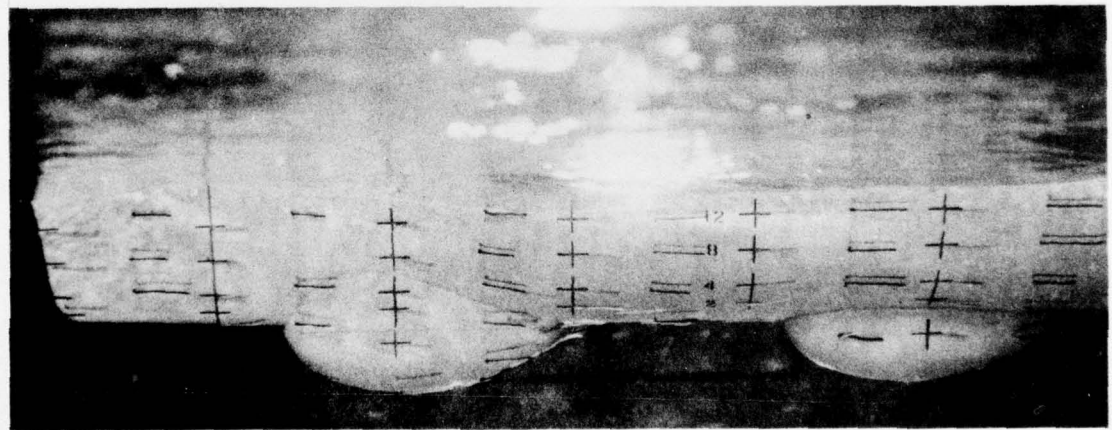
Bottom Views of Bow with Keel Domes at $V = 18$ Kts. (9.259 m/sec.)



Yaw Angle 3 Degrees to Stbd.



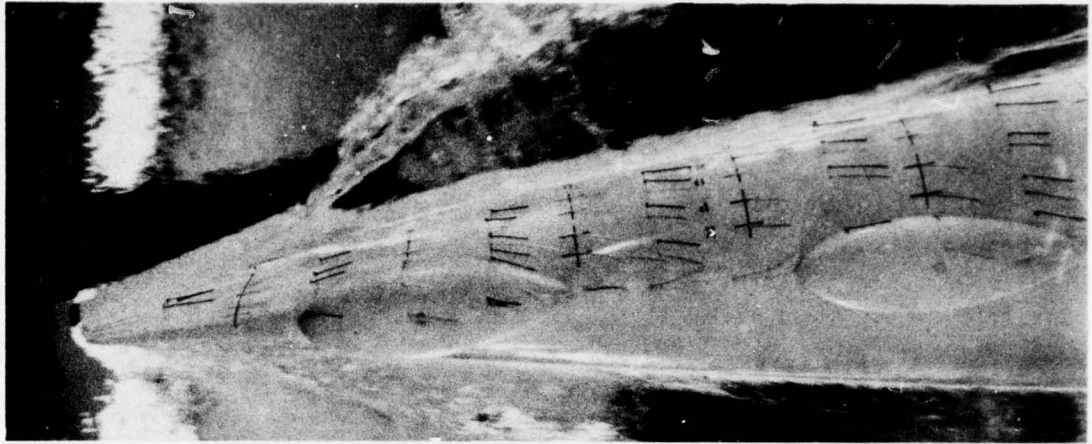
Yaw Angle Zero Degrees



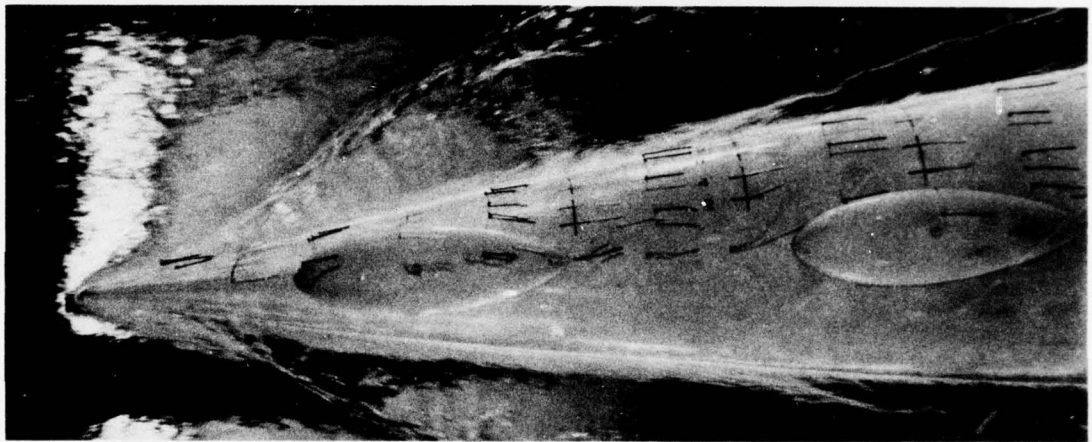
Yaw Angle 3 Degrees to Port

FIGURE 3

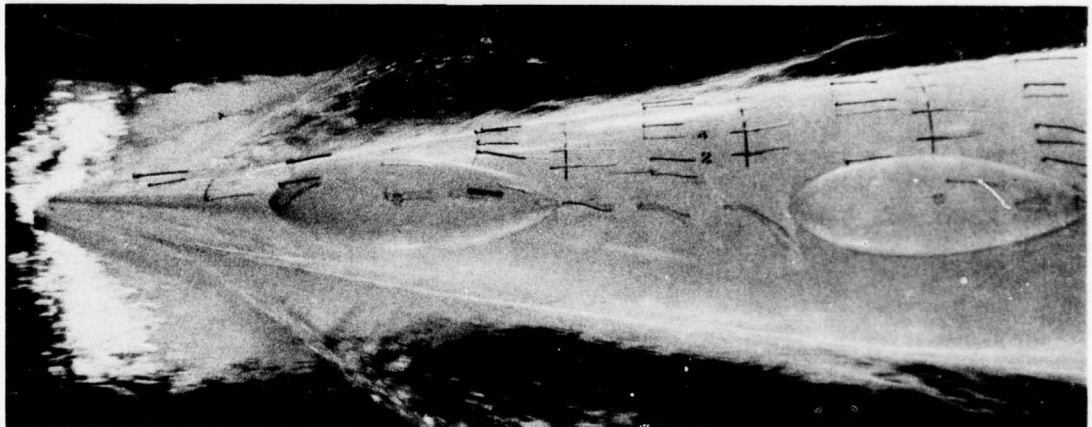
Side views of Bow with Keel Domes at $V = 18$ Kts. (9.259 m/sec)



Yaw Angle 3 Degrees to Stbd.



Yaw Angle Zero Degrees



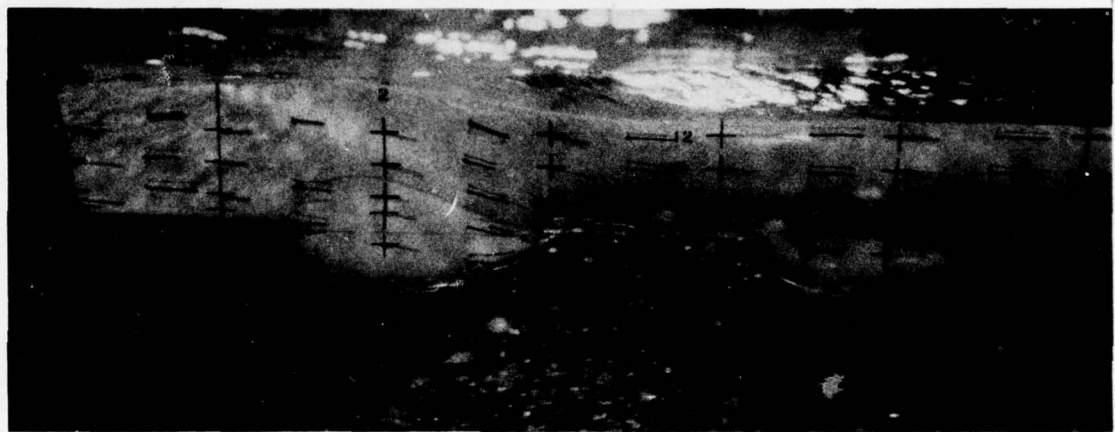
Yaw Angle 3 Degrees to Port

FIGURE 4

Bottom Views of Bow with Keel Domes at $V = 22$ Kts. (11.317 m/sec)



Yaw Angle 3 Degrees to Stbd.



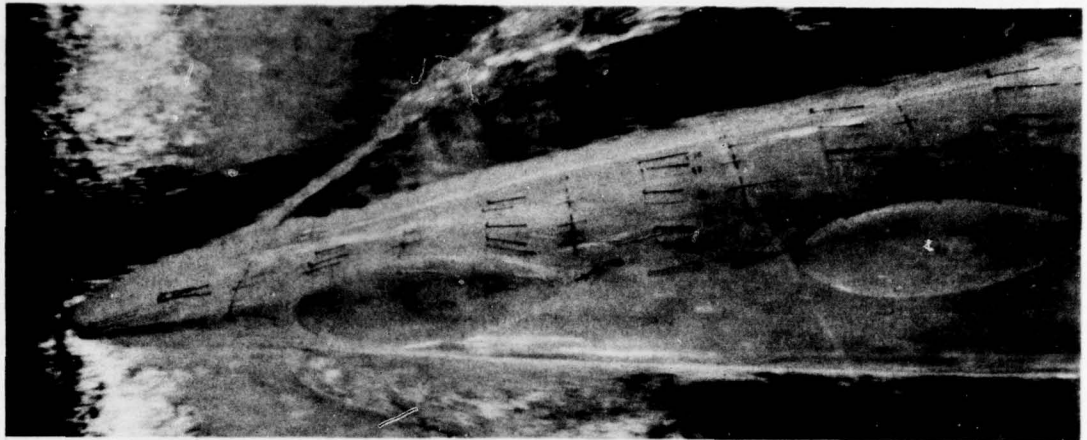
Yaw Angle Zero Degrees



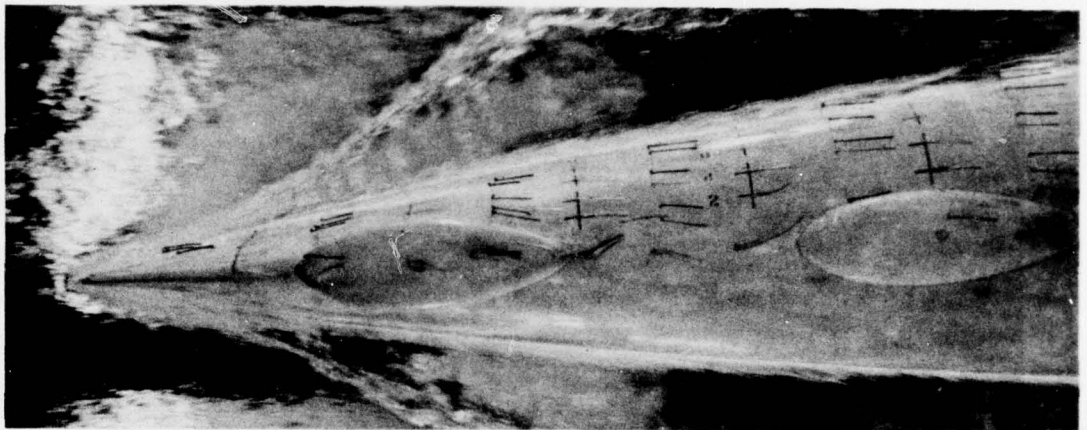
Yaw Angle 3 Degrees to Port

FIGURE 5

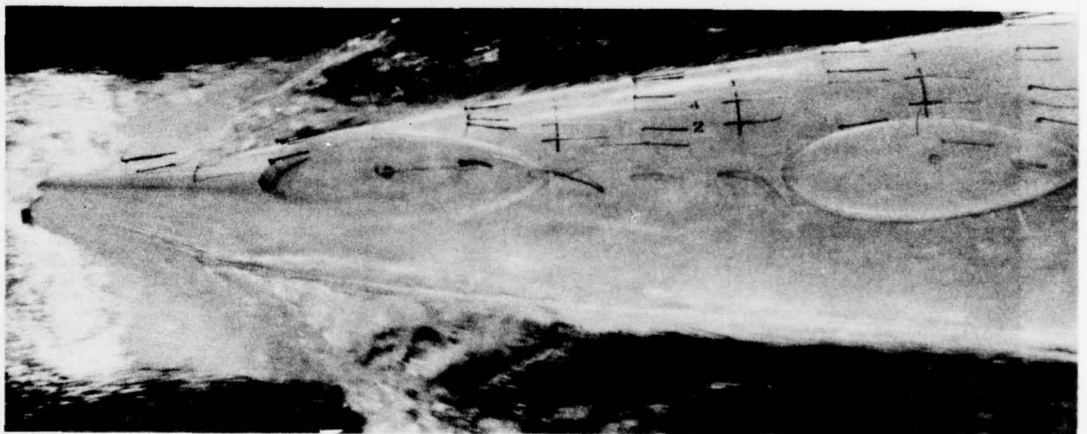
Side Views of Bow with Keel Domes at $V = 22$ Kts. (11.317 m/sec)



Yaw Angle 3 Degrees to Stbd.



Yaw Angle Zero Degrees



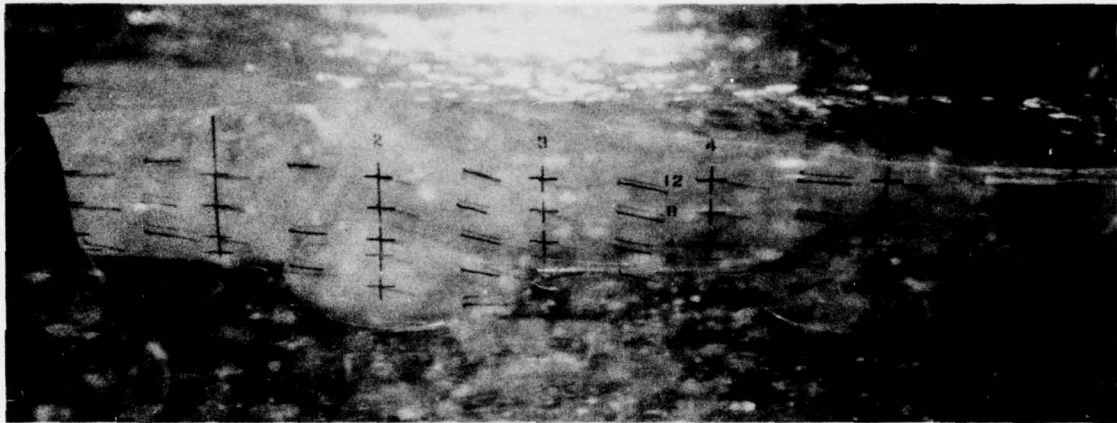
Yaw Angle 3 Degrees to Port

FIGURE 6

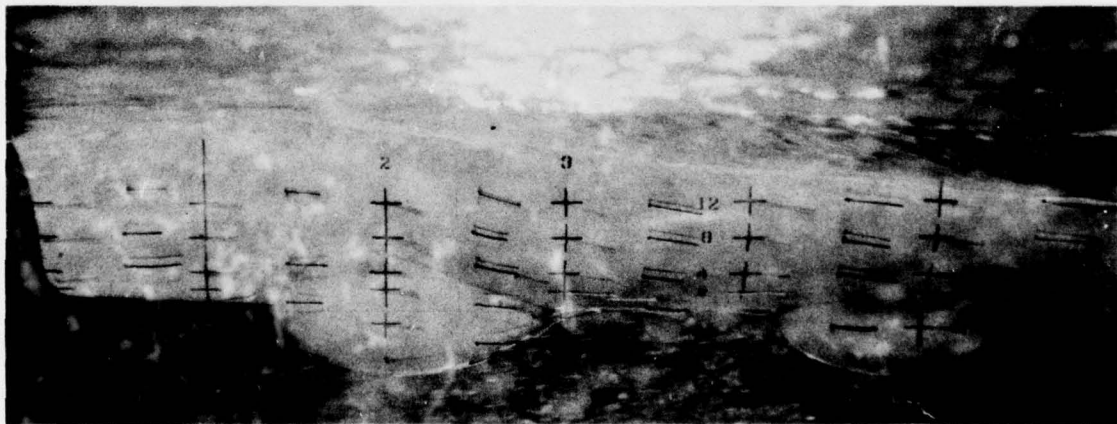
Bottom Views of Bow with Keel Domes at $V = 26$ Kts. (13.374 m/sec)



Yaw Angle 3 Degrees to Stbd.



Yaw Angle Zero Degrees



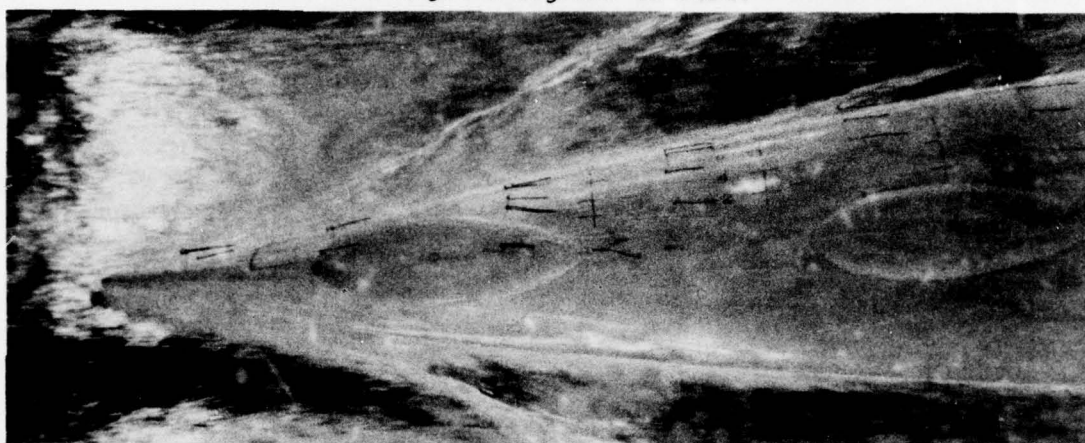
Yaw Angle 3 Degrees to Port

FIGURE 7

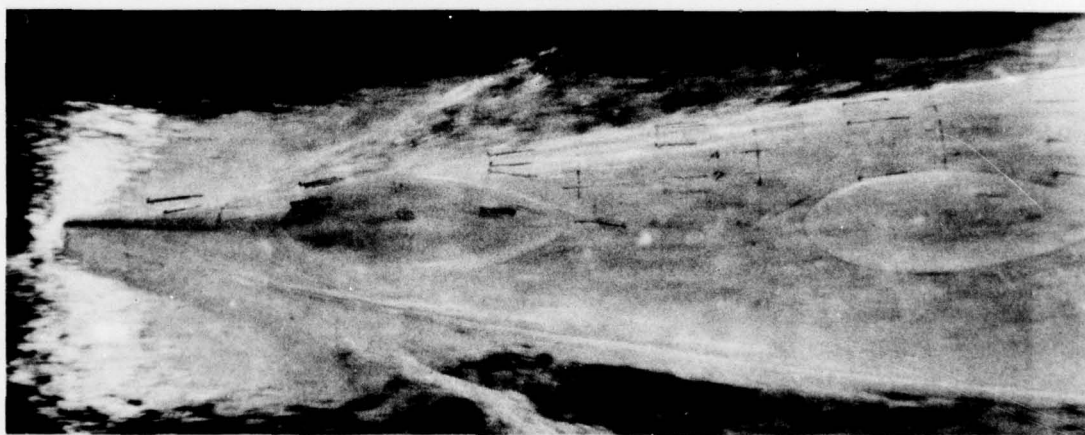
Side Views of Bow with Keel Domes at $V = 26$ Kts. (13.374 m/sec)



Yaw Angle 3 Degrees to Stbd.



Yaw Angle Zero Degrees



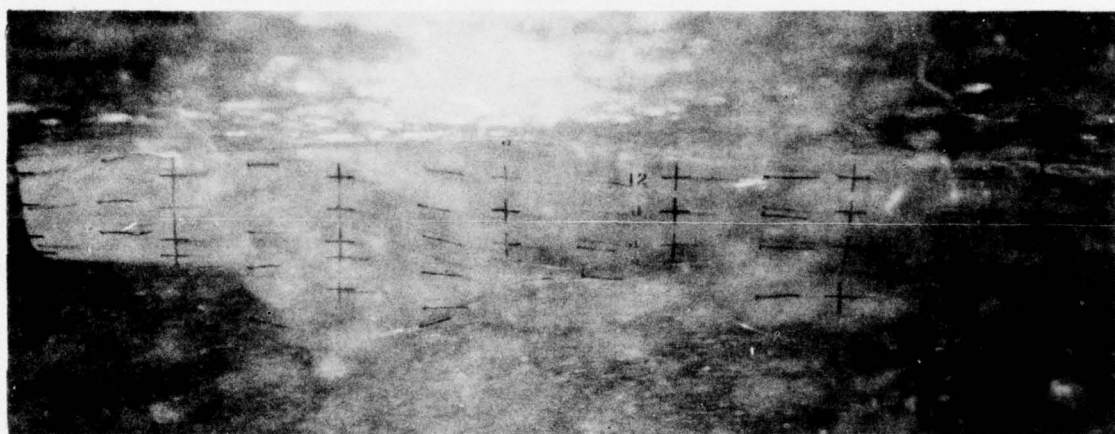
Yaw Angle 3 Degrees to Port

FIGURE 8

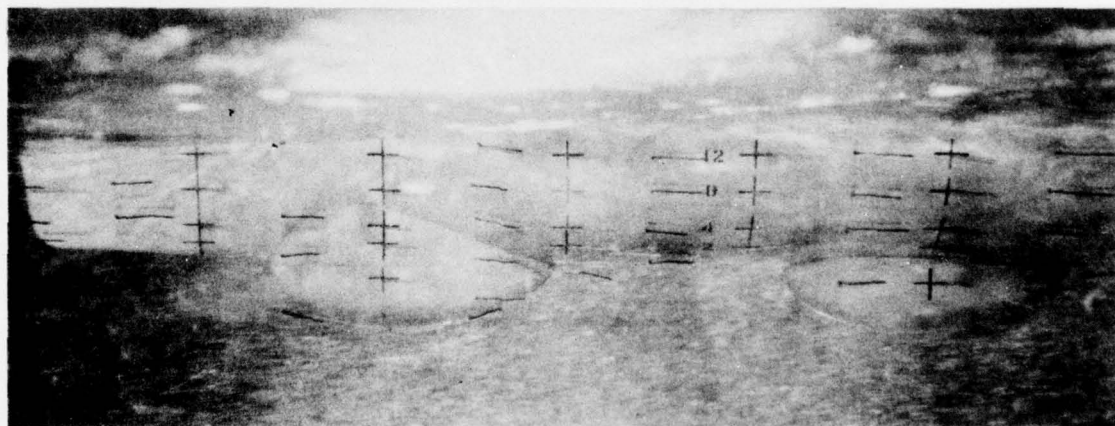
Bottom Views of Bow with Keel Domes at $V = 30$ Kts. (15.432 m/sec)



Yaw Angle 3 Degrees to Stbd.



Yaw Angle Zero Degrees



Yaw Angle 3 Degrees to Port

FIGURE 9

Side Views of Bow with Keel Domes at $V = 30$ Kts. (15.432 m/sec)

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